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14.4 ppm/.degree. C. Again, the back of the chip is very smooth resulting in a weak mechanical bond and any delamination or cracking of the epoxy between the chip and heat spreader causes a critical reduction in heat transfer from the chip which greatly increases the chip temperature. When this structure is subjected to storage at 130.degree. C. for 1000 hours then thermal cycling of 0 to 100.degree. C. for 1,500 cycles, then -25 to 125.degree. C. for 400 cycles, then -40 to 140.degree. C. for 300 cycles required to prove the reliability of joints between these materials, common epoxies quickly fail (delaminate). The applicants have discovered that with proper treatment a joint between silicon and nickel plated copper of either silicone adhesives (e.g. TC3280G) or flexible-epoxy adhesives (e.g. ABLEBOND 8971 and EG 7655) reliably meet the thermal cycling requirements of this test.

(23) FIG. 6 shows a direct chip attach module DCAM 300. Flip-chip 302 is attached to a multi-layer fiberglass epoxy substrate 304. Eutectic solder 306 is deposited (by hot air soldering and leveling (HASL), solder-on-chip, solder inject, by transfer from a stainless steel decal) to connect between high temperature solder bumps 308 (e.g. 95/5% Pb/Sn alloy) on the bottom of the chip and copper pads 310 on the top surface of the substrate.

(24) Copper pads 312 on the carrier substrate are positioned to connect to copper pads on an interconnect structure (organic circuit board as in FIGS. 2 and 5). Solder 314 may be provided on pads 312 for reflow soldered attachment. Alternatively, solder may be provided on the pads of the circuit board. Heat spreader 320 is attached to the back side of chip 302 using an adhesive 322 of flexible-epoxy or more preferably silicon. Improved mechanical strength can be obtained for heat spreaders which extend significantly past the limits of the chip by encapsulating between the heat spreader at 324 and substrate 304 using epoxy adhesives, silicone adhesives, or more preferably flexible-epoxy.

(25) FIG. 7 shows a computer network embodiment of the information handling system 350 of the invention. Computer

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US006069023A

United States Patent [19]

Bernier et al.

[11] Patent Number: 6,069,023

[45] Date of Patent: May 30, 2000

[54] ATTACHING HEAT SINKS DIRECTLY TO FLIP CHIPS AND CERAMIC CHIP CARRIERS

[75] Inventors: William Emmett Bernier, Endwell; Michael Anthony Gaynes; Irving Memis, both of Vestal; Hussain Shaukatullah, Endwell, all of N.Y.

[73] Assignee: International Business Machines Corporation, Armonk, N.Y.

[21] Appl. No.: 09/094,401

[22] Filed: Jun. 10, 1998

Related U.S. Application Data

[62] Division of application No. 08/672,875, Jun. 28, 1996, Pat. No. 5,847,929

[51] Int. Cl.⁷ H01L 21/44

[52] U.S. Cl. 438/107; 438/118; 438/119; 438/122

[58] Field of Search 438/107, 108, 438/118, 119, 122; 361/718, 719

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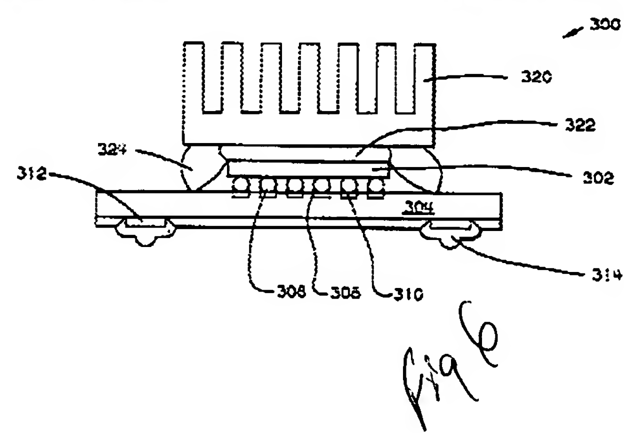
Primary Examiner—Carlidad Everhart
Attorney, Agent, or Firm—Pollock, Vande Sande & Amernick

[57] ABSTRACT

An aluminum or copper heat sink is attached to a ceramic cap or exposed semiconductor chip using an adhesive of silicon or flexible-epoxy adhesive. The aluminum may be coated by anodizing or Chromate conversion or the copper may be coated with nickel or gold Chromium. Such structures are especially useful for flip chip attachment to flexible or rigid organic circuit boards or modules such as CQFP, CBGA, CCGA, CPGA, TBGA, PBGA, DCAM, MCM-L, and other chip carrier packages in which the back side of chips are connected directly to heat sinks. These adhesive materials withstand wet or dry thermal cycle tests of −65 to 150° C. for 1,000 cycles and 85° C. and 85% relative humidity for 1000 hours while maintaining a tensile strength of at least 500 psi. The adhesive contains materials having high thermal conductivity and a low coefficient of thermal expansion (CTE) in order to provide increased thermal performance and a CTE between that of the silicon metal die and the metal of the heat sink.

46 Claims, 13 Drawing Sheets



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alumina ceramic;

Claims Text - CLTX (17):
the method further comprises filling the silicone adhesive with particles of aluminum metal;

Claims Text - CLTX (18):
the method further comprises selecting a one part silicone adhesive;

Claims Text - CLTX (32):
the depositing of silicone adhesive includes filling the space around the semiconductor chips between the heat sinks and the wiring surfaces with the silicone adhesive;

Claims Text - CLTX (50):
wherein depositing the silicone adhesive comprises depositing the adhesive between the heat sink and multiple semiconductor chips.

Claims Text - CLTX (56):
13. The method according to claim 1, wherein depositing the silicone adhesive comprises depositing the silicone adhesive around the semiconductor chips between the heat sinks and the conformal coating.

Claims Text - CLTX (58):
filling the silicone adhesive with particles of alumina ceramic.

Claims Text - CLTX (60):
filling the silicone adhesive with particles of aluminum metal.

Claims Text - CLTX (62):
selecting a one part silicone adhesive.

Claims Text - CLTX (82):
30. The method according to claim 1, wherein depositing the silicone adhesive includes filling the space around the semiconductor chip between the heat sink and the wiring surface with the silicone adhesive.

Claims Text - CLTX (106):
depositing silicone adhesive which is not fully cured between back surfaces of semiconductor chips and the heat sinks at respective windows;

cl.14

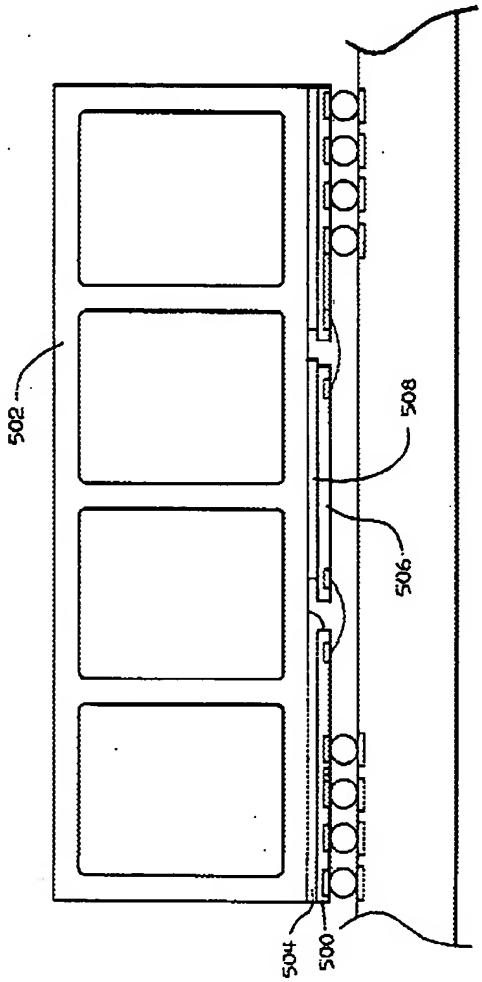

FIG. 12

EAST Browser - L12:

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Look in: Grid / Documents

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microelectroni... layer of elast... the recess 34.

(7) The lid ... cap 50 having a recess 52 adapted to receive the base 14. The recess 52 is defined by four side walls 54 and a base wall 56. The base wall 56 has a central opening 57 that is adapted to receive the second layer of elastomer gel 22. The side walls 54 define a close tolerance fit with the side walls 36 of the base 14 and include a continuous rib 58 that snap fits into a continuous groove 60 formed in the side walls 36. It should be understood that the snap fit rib and groove 58, 60 are shown simply to illustrate a releasable connection, and that any suitable form of releasable connection between the lid 20 and the base 14 may be utilized. Further, while it is preferred that the lid 20 be releasably connected to the base 14, it may be acceptable in some applications to form a permanent connection between the lid 20 and the base 14, using any known form of permanent connection that is appropriate for the application. While the lid 20 may be of a multi-piece construction and formed from any suitable materials, it is preferred that the lid 20 be a unitary construction molded from a suitable polymer having low dielectric properties, such as PEI or PEEK.

(8) It is preferred that the second layer of elastomer gel 22 be formed from a film, sheet, or pad of silicon elastomer gel or fluoro silicone elastomer gel having enhanced thermal conductivity, while also having sufficient structural stability to prevent undesirable flow of the gel over an anticipated temperature range for the particular application. Experience has shown that the thermal conductivity of such elastomer gels is comparatively insensitive to compression force, thereby providing acceptable thermal conductivity at their interfaces with other surfaces without requiring large compression forces. This is due, in part, to the inherent surface wetting capabilities of such elastomer gels. It is highly preferred that the thermal conductivity of the second layer of elastomer gel 22 be enhanced by using alumina, boron nitride, or aluminum nitride additives. It is also highly preferred that these additives be 60% to 80% by volume of the elastomer gel to optimize the thermal conductivity of the second layer of elastomer gel.

(9) The electrical contacts 22 are shown

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US005905638A

United States Patent [19] MacDonald, Jr. et al.

[11] Patent Number: 5,905,638

[45] Date of Patent: May 18, 1999

[54] METHOD AND APPARATUS FOR PACKAGING A MICROELECTRONIC DEVICE WITH AN ELASTOMER GEL

[75] Inventors: James D. MacDonald, Jr.; Walter M. ..., both of Apex; ... Gupta, Cary, all of N.C.

[73] Assignee: Ericsson Inc., Research Triangle Park, N.C.

[22] Filed: Dec. 18, 1997

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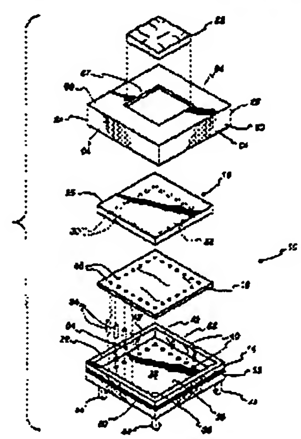
Primary Examiner—Donald Sparks

Attorney, Agent, or Firm—Wood, Phillips, VanSanten, Clark & Mortimer

[57] ABSTRACT

An apparatus and method for packaging a microelectronic device to be connectable to a distribution circuit. The apparatus is in the form of a microelectronic package including a microelectronic device having first and second oppositely facing surfaces and a plurality of input/output pads on the first surface capable of being electrically interconnected to a distribution circuit, a base adapted to support the microelectronic device in a predetermined operative relationship to a distribution circuit, and a first layer of elastomer gel sandwiched between the first surface and the base. The first surface of the microelectronic device overlays the base so as to allow an electrical interconnection through the base between the microelectronic device and a distribution circuit.

25 Claims, 2 Drawing Sheets



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